Supplementary data

Carbon nanofibers/nanosheets hybrid derived from cornstalks as sustainable anode for Li-ion batteries

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Experimental

Synthesis of CNFS

The dried and cleaned cornstalks were initially processed into slices (length: ~1 cm; width: ~1 cm). Within the underlying hydrothermal treatment, 1 g of prepared cornstalk slices was immersed in a Teflon-lined stainless steel autoclave wherein 70 mL of 2 M KOH solution was contained, then the autoclave was heated at a temperature of 150 °C for 4 h. When cooled down to room temperature, the samples were collected by vacuum filtration, and washed by 200 mL deionized water and dried in an oven at 80 °C. The following high temperature pyrolysis and chemically activation was carried out at 800 °C for 4 h under the protection of N_2 atmosphere. The carbonaceous product was washed with deionized water, and dried.

Characterization of the samples

Morphologies and microstructures of the CNFS were characterized by filed-emission scanning electron microscopy (FE-SEM, Hitachi, S-4800), transmission electron microscopy (TEM) and high-resolution TEM (HRTEM, JEOL 2010), X-ray diffraction patterns (XRD, Rigaku D/Max-2400), and Raman spectra (labRAM ARAMIS). The Brunauer-Emmett-Teller (BET) specific surface area and pore-size distribution were determined by nitrogen adsorption-desorption at 77 K (Quantachrome Autosorb-1C-VP Analyzer). The carbon and nitrogen contents were measured by Vario EL cube organic element analyzer. Composition of the CNFS

were investigated by X-ray photoelectron spectroscopy (XPS) using an AXIS Ultra instrument from Kratos Analytical.

Electrochemical measurements

To investigate the electrochemical properties, the working electrode with 90% CNFS and 10% PVDF binder on copper-foil collector was fabricated. The loading of active material was around 3 mg cm^{-2}. The obtained electrode, polyethene separator and Li metal foil were assembled into a 2032 type coin cell filled with electrolytes (1 M $LiPF_6$ in ethylene carbonate-dimethyl carbonate) in Ar filled glove box. Electrochemical data were collected using LAND CT2001A test system within the potential range of 0.01–3.0 V *vs.* Li^+/Li at various current densities. Cyclic voltammograms (CVs) were recorded on CHI 660E electrochemistry workstation at a scan rate of 0.1 mV s^{-1} between 0.01 and 3.0 V *vs.* Li^+/Li. Electrochemical impedance spectroscopy (EIS) tests were made after different cycles with the frequency range of 10 mHz to 10 MHz.

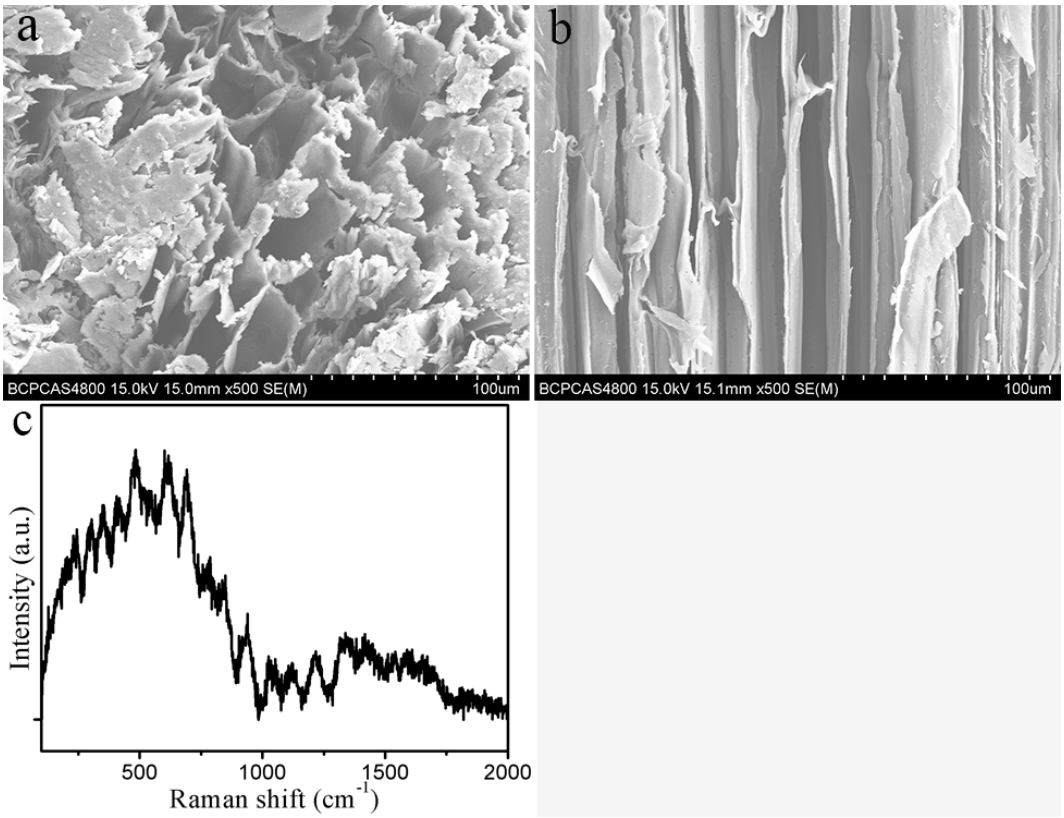

Fig. S1 (a,b) SEM images and (c) Raman spectra of the cornstalk.

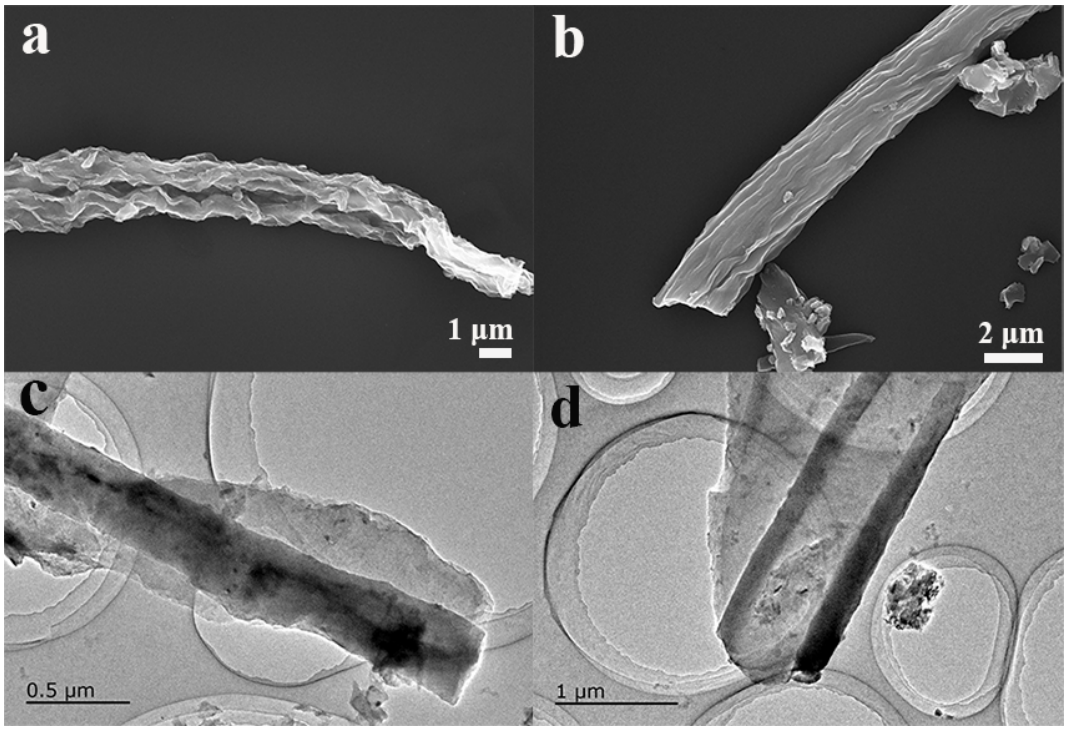

Fig. S2 SEM and TEM images of the carbon nanofibers.

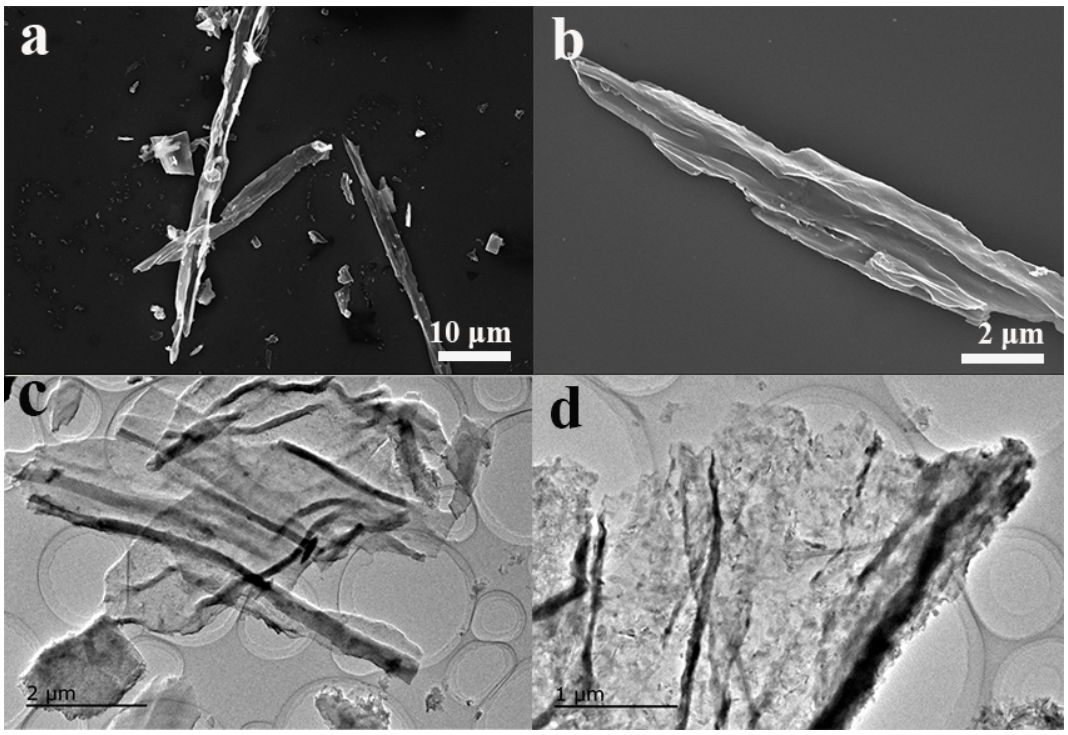

Fig. S3 SEM and TEM images of the carbon nanosheets.

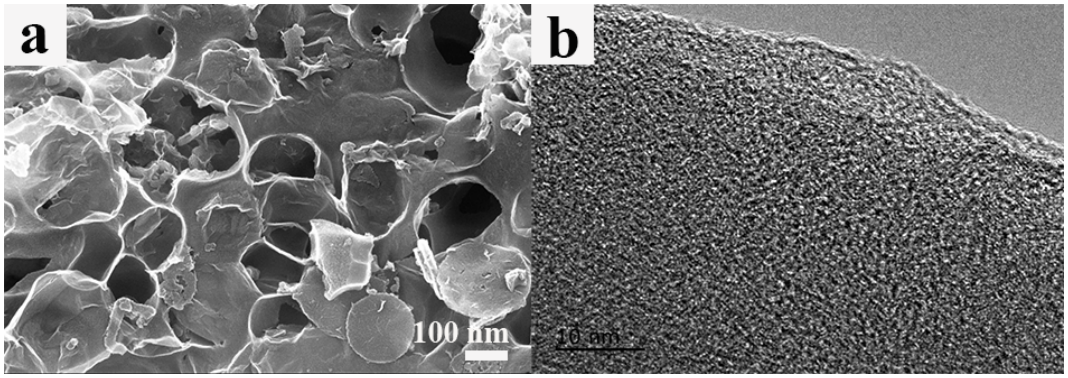

Fig. S4 a) macropores and b) micropores of the CNFS. The HRTEM image show the disordered lattice fringe of carbon.

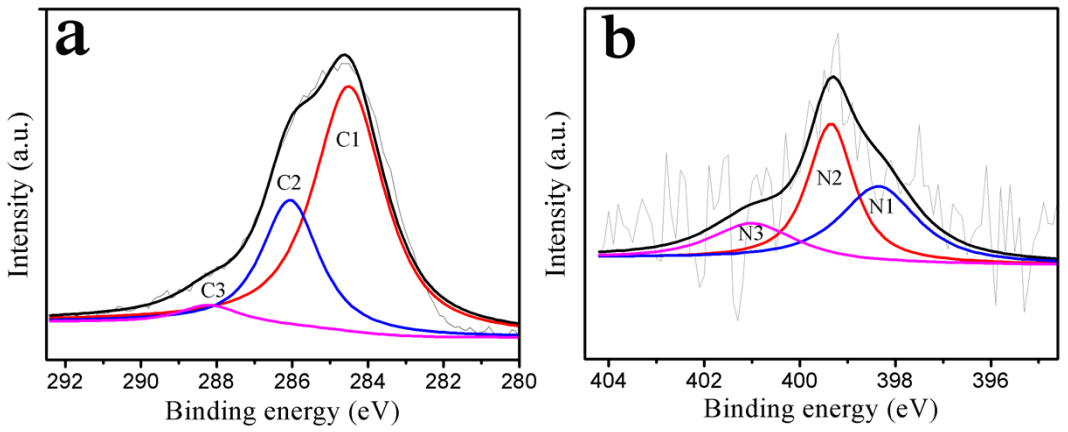

Fig. S5 The XPS spectrums of a) C1s, and b) N1s.

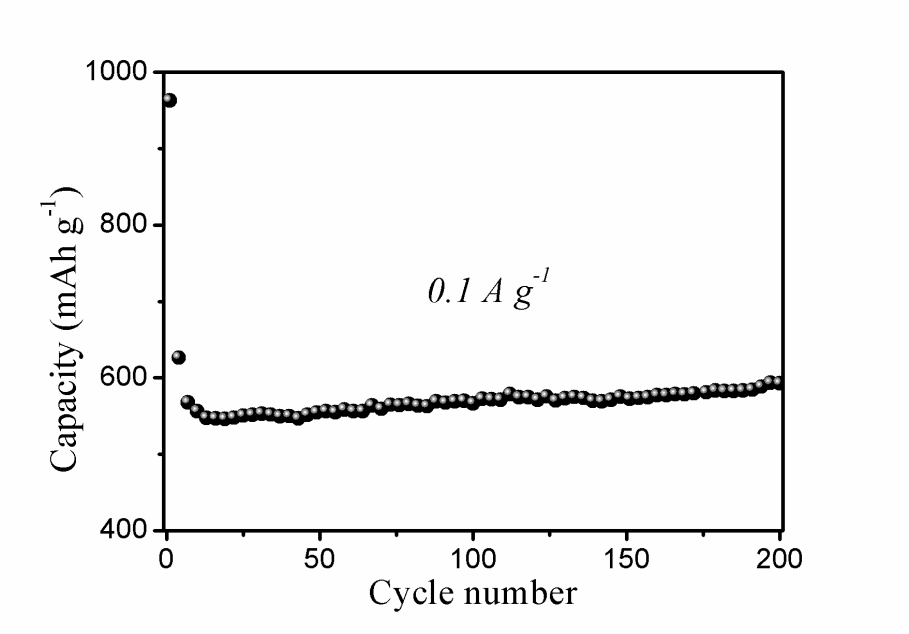

Fig. S6 Cyclability of CNFS at 0.1 A g^{-1}.

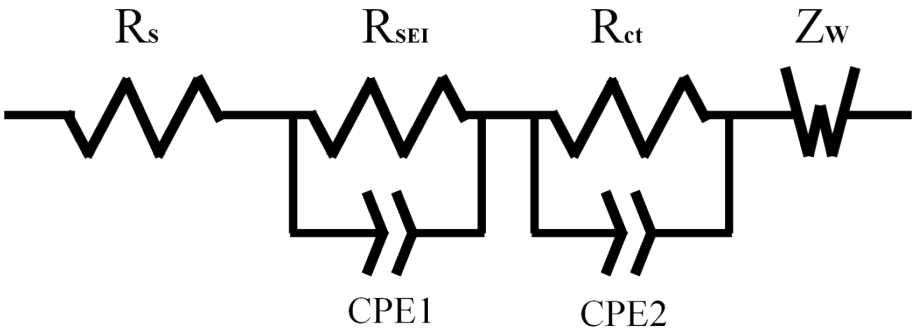

Fig. S7 The equivalent circuit used of CNFS after cycling.

Table S1. Kinetic Parameters of the CNFS Electrode				
$R_s(\Omega)$	$R_{SEI}(\Omega)$	$R_{ct}(\Omega)$	$CPE_1(F)$	$CPE_2(F)$
1.2	8.6	10.3	1.3×10^{-4}	3.9×10^{-4}

Table S2. Comparison of the electrochemical performances of CNFS and some other typically carbon materials derived from biomass.					
Carbon source	Mass loading (mg cm^{-2})	Reversible capacity (mAh g^{-1})		Rate-retention (%)	Ref.
cornstalk	3	592 at 0.1 A g^{-1}	454 at 3 A g^{-1}	77	This

					work
wheat straw	8	1129 at 0.185 A g^{-1}	664 at 3.7 A g^{-1}	59	[S1]
bamboo	2.5-4	353 at 0.17 A g^{-1}	137 at 4.6 A g^{-1}	39	[S2]
Banana peels	0.5	700 at 0.1 A g^{-1}	400 at 3 A g^{-1}	57	[S3]
Rice husk		218 at 0.37 A g^{-1}	137 at 3.75 A g^{-1}	62	[S4]
Cotton cellulose		700 at 0.1 A g^{-1}	240 at 2 A g^{-1}	34	[S5]
Egg white		1780 at 0.1 A g^{-1}	205 at 4 A g^{-1}	11	[S6]
Rice straws		986 at 0.1 C	257 at 2 C	26	[S7]

References

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